

System Inspector Manual

CHAPTER 8 - MATHEMATICS REVIEW

This section provides a quick review of pertinent mathematical definitions, formulas and units of measurement that are valuable to the System Inspector.

Definitions:

Area: The measurement of a surface in square units such as square feet, square inches, etc.

Circumference of a Circle: The length of the external boundary of a circle such as the rim on a basketball hoop which is 62" around.

Diameter of a Circle: Distance from one side of a circle to the other through the center point, such as a three inch inside diameter of a pipe.

Hydraulic Soil Loading Rate: The number of gallons of wastewater applied to an area of soil in a day, such as 0.6 gallons/day/ft².

Pi (π): A known ratio that is a constant in the geometry of circles (3.1416).

Pressure: The force applied to a unit area, usually given in pounds per square inch.

Radius: One half the diameter of a circle.

Volume: The capacity of a container such as a cubic yard of loam or a 55 gallon drum.

Common Units of Measurement:

Area: Square inches, square feet, square yards, acres

Length: Inches, feet, yards, miles, meters

Volume: Cubic inches, cubic feet, cubic yards, gallons, liters

Pressure: Pounds per square inch (psi), pounds per square foot

Concentration: Milligrams/liter, pounds/gallon

Flow rate: Gallons per minute (gpm), gallons per day (gpd), millions of gallons per day (MGD), cubic feet per second (cfs)

Time: Seconds, minutes, hours, days

Abbreviations:

l = liter

l = length, w = width, h = height, r = radius, d = diameter

A = area

V = velocity

ft² = square feet

Q = flow rate

ft³ = cubic feet

in = inches

m³ = cubic meters

gpm = gallons per minute

gpd = gallons per day

gpd/ft² = gallons per day per square feet

cfs = cubic feet per second

% = percent

ac = acre

ppm = parts per million

> = greater than

< = less than

psi = pounds per square inch

min = minute

ml = milliliter

cm = centimeters

π (pi) = 3.14

1 gallon of water weighs 8.34 pounds

Important conversion factors:

Multiply	By	To Obtain
acre	43,560	square feet
cubic feet	7.5	gallons
cubic feet per second	0.646	million gallons per day (MGD)
diameter (d)	0.5	radius (r)
inches of mercury	1.133	feet of water
million gallons per day (MGD)	1.55	cubic feet per second (cfs)
pounds per square inch (psi)	2.31	feet of water
feet of water	0.434	Pounds per square inch (psi)
gallons per minute	1440	gallons per day (gpd)

Important equations:

Circumference of a Circle = $2(\pi)(r)$

Area of a Circle = $\pi(r^2)$

Area of a rectangle or square = $(l)(w)$

Volume of a Cylinder = $\pi(r^2)h$, where h = height

Volume of a rectangular tank = $(l)(w)(h)$

1 Cubic foot = 7.5 gallons

Detention time (hrs) = (tank volume)/(flow rate) - units must be consistent

Hydraulic soil loading rate = gallons applied per day (gpd)/(area applied (ft²))

Radius (r) = $\frac{1}{2}$ diameter (d)

Practice Math Problems

These math problems are designed to allow you to practice your skill using the information provided in the definitions, common units of measure, abbreviations, important conversion factors and important equations sections of this chapter. The problems are purposely kept uncomplicated so that you can practice using the individual definitions and formulas. The answers to each question are included on the pages following the questions.

Since real life situations will often involve a series of mathematical calculations rather than the simple forms given here, you must go one step further: learn to take a complex problem, write it down, separate it into simpler parts and then do the calculations presented here, no matter how complex the actual problem.

1. What is the volume of a septic tank with the following dimensions: $l = 5'$, $h = 10'$, $w = 12'$?
 - a. 540 cubic feet
 - b. 600 cubic feet
 - c. 5400 cubic feet
 - d. 300 cubic feet
2. What is the maximum number of gallons of water which the septic tank in question 1 could hold?
 - a. 3500 gallons
 - b. 4500 gallons
 - c. 5500 gallons
 - d. 4425 gallons
3. What is the volume of a cylindrical septic tank if the diameter of the tank is 12 feet and the height of the tank is 8 feet?
 - a. 905 cubic feet
 - b. 175 cubic feet
 - c. 102 cubic feet
 - d. 1750 cubic feet
4. If the water in a cylindrical tank, which is 12 feet in diameter and 8 feet deep, drops 5 feet in 5 hours, how many gallons per minute are being lost?
 - a. 11 gpm
 - b. 14 gpm
 - c. 848 gpm
 - d. 120 gpm
5. You know that a household is using 345 gallons per day of water and you want to know how much space that takes up in a septic tank.
 - a. 46 cubic feet
 - b. 109 cubic feet
 - c. 481 cubic feet

- d. 19 cubic feet
- 6. You know a household used 23,450 cubic feet of water last year. Calculate how much water they used per day in gallons.
 - a. 64 gpd
 - b. 482 gpd
 - c. 621 gpd
 - d. 23 gpd
- 7. Add 225 gallons of water to 309 gallons of water and convert this to cubic feet.
 - a. 4005
 - b. 534
 - c. 423
 - d. 71
- 8. If a rectangular septic tank has a horizontal surface area of 120 square feet and is 8 feet wide, how long is it?
 - a. 10 feet
 - b. 15 feet
 - c. 25 feet
 - d. 12 feet
- 9. What is the area of a circle with a radius of twelve feet?
 - a. 657 square feet
 - b. 235 square feet
 - c. 821 square feet
 - d. 452 square feet
- 10. If a circular septic tank has a horizontal surface area of 285 square feet, what is its diameter?
 - a. 41.5 feet
 - b. 9.5 feet
 - c. 19 feet
 - d. 81 feet

Answers

- 1. 600 cubic feet. Note that the units of measure are feet X feet X feet that yield the answer in cubic feet.
- 2. Using the conversion factor for cubic feet to gallons, we multiply the volume (600 cubic feet) times 7.5 and get 4500 gallons. Note that since we are using a conversion factor, the units of measure changes from cubic feet to gallons.
- 3. 905 cubic feet. Using the formula for the volume of a cylinder ($v = \pi r^2 h$) where

$v = 3.1416 \times 6^2 \times 8$. Keep in mind the fact that the diameter is twice the radius, therefore, the value of r is 6 feet.

4. The solution to this problem must be taken in steps: first, figure the volume of water lost in 5 hours by doing a simple cylinder volume calculation ($v = \pi r^2 h$) where $v = 3.1416 \times 6^2 \times 5 = 566$ cubic feet of water lost. Second, we account for the time by dividing the number of cubic feet of water lost by 5 hours = 113 cubic feet per hour and then dividing that by 60 minutes = 1.9 cubic feet per minute. Finally, we convert that to gallons by using the conversion factor, 7.5, and getting a product of 14 gallons per minute.

5. This is a conversion of gallons of water to cubic feet of water. Divide the number of gallons by 7.5 to get 46 cubic feet of water.

6. This is a conversion of cubic feet of water to gallons of water. You multiply the cubic feet by the conversion factor (7.5). Now divide that by 365 days and get 482 gallons per day.

7. Take the problem in two steps: first, add the gallons to get 534 gallons of water, now divide the total gallons by the conversion factor (7.5) to get the 71 cubic feet of water.

8. Since a surface area is the product of the width \times length of an object, we can divide the surface area by the width (8 feet) and get the length (15 feet).

9. We use the formula for the area for a circle ($a = \pi r^2$) to solve this problem. We know that r is the radius and equals 12 feet. Square that by multiplying $12 \times 12 = 144$. Next, we multiply $144 \times \pi$ or 3.1417 for an answer of 452 square feet.

10. The solution involves using the formula for the area of a circle and calculating backwards. The formula is $a = \pi r^2$. We know that $a = 285$ square feet; π (pi) is a constant and equals 3.1416. The only part of the problem we don't know is the r^2 . In order to find r^2 we are going to modify the basic formulas ($a = \pi r^2$) by dividing both sides of the formula by π or 3.1416 with a result of 91. Since this is r^2 we must find the square root of 91 which is 9.5 feet or the radius of the circle. The diameter is twice the radius or 19 feet.